

1 The present invention accomplishes this result in part by the use of one or more preformed
2 sacrificial guides. The preformed sacrificial guide cooperates with a pilot in the much larger
3 soil processing tool to assure that the larger tool remains centered and bores downwardly in
4 essentially a perfectly vertical path. By using the preformed sacrificial guide, large arrays of
5 soil cement columns may be formed in processing large volumes of underground earth sites.
6 In many of these large underground sites, it is critical that the entire volume of the
7 underground site be either solidified into a rather solid soil cement mixture or thoroughly
8 processed to assure a uniform result. For example, for support of an airport runway, the
9 underground material beneath the runway must have uniform strength. As another example,
10 in treating a large underground radioactive plume, it is critical that the entire volume of the
11 plume be solidified or otherwise treated to minimize future movement of the radioactive
12 materials in underground water tables.

13 The present invention also provides for the first time a method for forming soil-cement
14 columns of any diameter that have very precise verticality and precise centering. This high
15 degree of precision is achieved by using a sacrificial guide to position and guide the soil
16 processing tool.

17 The present invention contemplates the use of some aspects of my prior patents,
18 including U.S. patents 4,793,740; 4,958,962; 5,396,964; 6,183,166 and 6,241,426, all of which
19 are incorporated by reference as though set forth in full herein.

20 Portions of those prior patents are utilized in conjunction with the present invention and
21 some significant portions of those prior patents will be described herein as they pertain to the
22 present invention.

23 The overall concept of the present invention is to first form a sacrificial guide with a soil
24 cement mixture and allow the guide to harden sufficiently to act as a pilot for a larger soil
25 processing tool. The pilot shaft of the larger soil processing tool is centered in and guided by
26 the preformed sacrificial guide as the large processing tool begins moving downwardly. As

1 the soil processing tool moves downwardly, its heavy, rotating teeth break up and fragment
2 the sacrificial guide into soil cement particles so that the soil cement mixture utilized to form
3 the sacrificial guide is eventually interspersed into the much larger soil cement column formed
4 by the large scale processing tool. The result is a precisely placed, large diameter and
5 homogeneous soil cement column. An array of such columns can be placed very accurately
6 in order to solidify or otherwise process very large underground sites.

7 The sacrificial guide may be either a hollow or a solid cylinder and formed, for example,
8 by the technique taught in my U.S. patent 6,183,166. If the sacrificial guide is hollow, the pilot
9 of the larger soil processing tool is centered and guided by the hollow sacrificial guide. If the
10 sacrificial guide is a solid cylinder, it has a relatively soft center and a relatively hard outer
11 region. In this embodiment, the larger soil processing tool has a pilot which is tipped with an
12 auger. The auger drills out the soft center of the guide, but is simultaneously centered and
13 guided by the hard, outer region of the guide.

14 A primary object of the invention is to provide a method for hardening or solidifying large
15 volumes of material located in a subterranean earth situs so that the earth situs may be used
16 to support structures carrying large loads such as airport runways.

17 Another object of the invention is to provide a method for forming underground soil-
18 cement columns of any diameter wherein the columns are formed by using a sacrificial guide
19 and the resultant columns have a higher degree of verticality and more precise centering than
20 known in the prior art.

21 A further object is to provide a method of forming underground soil-cement columns
22 utilizing a soil-cement sacrificial guide, wherein the guide becomes broken up and fragmented
23 to form a part of the resultant soil-cement column.

24 Another object of the invention is to provide a method for forming a sacrificial guide
25 which centers and guides a large diameter soil processing tool having a diameter of more than
26 8 feet which can be controlled and guided to form precision vertical soil-cement columns

1 centered at precise locations.

2 A further object is to provide a method for hardening or solidifying large subterranean
3 volumes of material wherein an array of sacrificial guides is formed and those sacrificial guides
4 are used to guide and control large diameter soil processing tools to form soil-cement columns
5 in the situs.

6 Other objects and advantages of the invention will become apparent from the following
7 description of the drawings wherein:

8 Brief Description of the Drawings

9 Fig. 1 illustrates a small diameter soil processing tool forming a soil-cement column as
10 it advances downwardly and forms a hole by mechanically and hydraulically dividing the
11 material in the hole created by the tool;

12 Fig. 2 illustrates the auger shaped soil processing tool as being withdrawn and
13 vigorously rotated to form a relatively hard outer casing and relatively soft inner portion of the
14 soil-cement column;

15 Fig. 3 illustrates the soil-cement column having an outer relatively hard region and an
16 inner relatively soft region;

17 Fig. 4 shows the hole after the soil-cement has been allowed to set up;

18 Fig. 5 illustrates one embodiment of the invention wherein the softer center region has
19 been drilled out to form a hollow underground casing;

20 Fig. 6 illustrates the introduction of a very large soil processing tool having a pilot
21 wherein the pilot is centered by and guided by the hollow underground casing illustrated in Fig.
22 5;

23 Fig. 7 illustrates a large soil-cement column left by the large diameter soil processing
24 tool after it has been withdrawn;

25 Fig. 8 illustrates an array of sacrificial guides which have been laid out in a grid-like
26 pattern;

1 Fig. 9 illustrates schematically the diameter of large soil-cement columns 150 to be
2 formed using the casings 30 as sacrificial guides;

3 Fig. 10 illustrates one method of hardening or solidifying the interstitial spaces between
4 large soil-cement columns illustrated in Fig. 9;

5 Fig. 11 illustrates an alternate array of sacrificial guides wherein the centers of any
6 three adjacent sacrificial guides form an equilateral triangular;

7 Fig. 12 illustrates an embodiment of the invention intended to solidify or harden or
8 otherwise process virtually 100% of the soil in the subterranean earth situs being treated; and

9 Fig. 13 illustrates an alternate embodiment using a solid cylindrical sacrificial guide.

10 Detailed Description of the Drawings

11 Figs. 1-5 show the formation of the sacrificial guide using essentially the technology
12 shown and described in U.S. patent 6,183,166 dated February 6, 2001. Certain portions of
13 that disclosure are repeated herein for reference.

14 As shown in Figs. 1-3, a small diameter soil processing tool 10 is provided having a
15 hollow stem 11, a first stage 85 and second stage 90. As used herein and in the claims, the
16 phrase "small diameter" means a diameter of tool 10 between 1 and 5 feet. First stage 85 has
17 four helical flights 12,13,14 and 15 and cutting tip 16. Cutting tip 16 typically has cutting teeth
18 known in the art; cutting teeth are not shown in the drawings for clarity. Helical flights 12-15
19 are preferably as shown and described in greater detail in Fig. 12 of U.S. patent 5,396,964,
20 owned by the assignee of the instant application. U.S. patents 5,396,964; 4,793,740 and
21 4,958,962 are hereby incorporated by reference as if set forth in full. The second stage 90
22 has four helical flights 92,93,94 and 95. The outer diameter of helical flights 12-15 of the first
23 stage 85 is smaller than the outer diameter of helical flights 92-95 of second stage 90. The
24 second stage 90 has a wear resistant cutting surface 96 similar to cutting tip 16 and nozzle
25 97 through which cement slurry is pumped.